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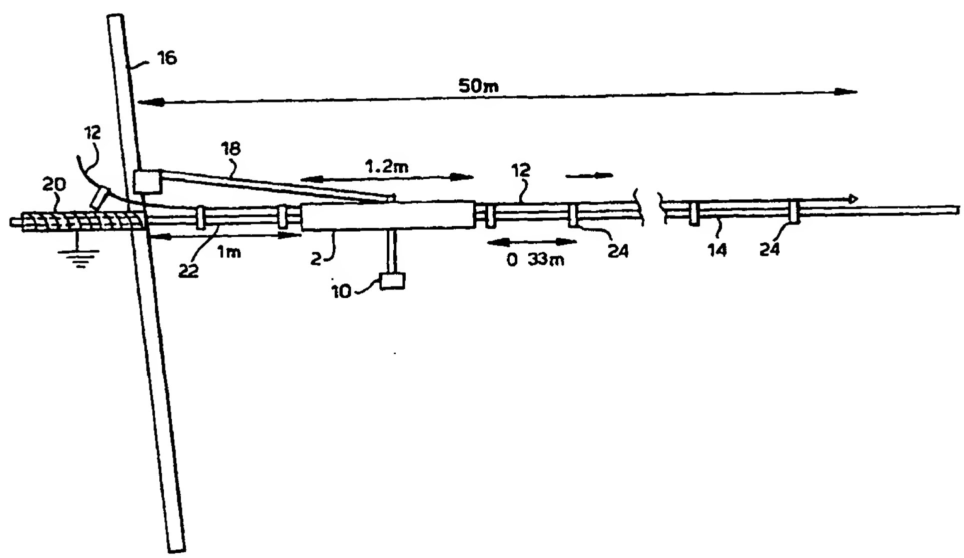
(54) Title: METHOD OF INSTALLING A RESISTIVE ELEMENT ON AN OPTICAL CABLE



(57) Abstract

A method of installing a resistive element (12) along part of an optical cable (14) that extends between, and is supported by, towers of an overhead electrical power transmission system, comprises attaching one end of the element to the optical cable at a tower, feeding the element out along the cable from the tower, and attaching intermediate parts of the element to the optical cable if necessary. The method is characterised in that: (i) the optical cable is earthed at a location adjacent to the tower by attaching to the cable a grounding device that is electrically connected to the tower; (ii) the resistive element is attached to the optical cable at a position on the optical cable between the tower and the location at which the optical cable is earthed by the grounding device, and is fed out along the optical cable from that position; (iii) as the resistive element is fed out along the optical cable, it contacts the grounding device which provides a path to earth for induced electrical currents thereon.

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Method of installing a Resistive Element on an Optical Cable

This invention relates to optical cables that are supported along the route of the system by means of towers, masts or other upstanding supports that are also employed to support electrical power cables.

In systems of this kind it is the general practice to earth the optical cable or cables at the towers, masts or other supports (hereinafter simply referred to as towers) by means of a metallic cable clamp. When the electrical power lines are on load, electrical currents may be capacitively induced on the optical cable due to the distributed capacitance between the cable and the power lines. The voltage induced on the optical cable will reach a maximum at mid-span between the towers, while the current flowing along the cable will be greatest in the region of the towers. Under dry conditions the induced currents will be relatively small due to the relatively high longitudinal resistance of the cable, e.g. in the region of 10^{12} ohm m^{-1} but under wet conditions when the surface resistance of the cable is much lower, e.g. in the order of 10 Mohm m^{-1}, much higher currents will be induced. Joule heating of the cable surface by the induced currents can cause a short length of the cable surface to become dry, usually in the region of a tower where the current is highest. When this happens the major part of the induced voltage on the cable is dropped across the short dry band due to its high longitudinal resistance, and so called "dry-band arcing" may occur which can cause severe damage to the cable.

It is possible to overcome the problem of dry-band-arcing in an optical cable by providing the cable with a longitudinally extending electrically conductive path. However, an optical cable having such an electrically conductive path has the

disadvantage that there are considerable safety issues to be taken into account if it is to be installed between towers of an overhead electric power transmissions line that is on load in view of the danger of it touching one of the transmission lines; moreover, it is not always possible or desirable to interrupt the electrical power transmitted by the overhead electric power transmission line for a time sufficient to enable such an optical cable to be installed.

It has been proposed in our co-pending international patent application No. PCT/GB94/02675 that a resistive element extends along the optical cable from the tower, where it is earthed, part of the way along the span of the optical cable. Such an element will prevent dry-band arcing on the optical cable along the length of the element, and if any dry band forms on the cable at the end of the element the potential difference across the band will be insufficient to form an arc, and/or the induced current will be insufficient to sustain any arc that forms.

In order to install the element, one end of the element is attached to the optical cable at a tower for example by means of clip or other device, and the element is fed out along the cable from the tower, intermediate parts of the element being attached to the optical cable if necessary. However, this installation procedure will normally be conducted while the high voltage transmission system is on load, and it is therefore necessary to ensure that no installation personnel are subject to any voltages or currents that may be induced on the element as it is installed.

According to the present invention the method is <u>characterised in that</u>:

(i) the optical cable is additionally earthed at a location adjacent to the tower by attaching to the cable a grounding device that is electrically connected to the tower;

(ii) the resistive element is attached to the optical cable at a position on the optical cable between the tower and the location at which the optical cable is earthed by the grounding device, and is fed out along the optical cable from that position, and

(iii) as the resistive element is fed out along the optical cable, it contacts the grounding device which provides a path to earth for induced electrical currents thereon.

The method according to the invention has the advantage that the only part of the resistive element that needs to be manipulated by the installation personnel is that part located between the tower and the grounding device so that the element can be installed on the optical cable with no risk of electrocution to the installation personnel.

It is possible for the grounding device to be left in situ after the resistive element has been installed so that it can be used at a later date when it is desired to change the element, although this would not normally be economically practical. Thus, the invention will normally include the further steps of:

(a) forming a permanent earth connection between the resistive element and the tower after the resistive element has been fed out to its full extent; and

(b) after the permanent earth connection has been formed, removing the grounding device.

In such a method, only a single grounding device need be employed.

Preferably the grounding device has a substantially "C"-shaped cross-section so that it can readily be attached to and removed from, the optical cable. For example, the device may be in the form of a tube having a longitudinally extending slot that enables the tube to be hooked on to the optical cable and then unhooked after the resistive element has been installed. In addition, the device preferably includes a weight which ensures that the device is correctly oriented about the optical cable. For example, in the case of a device of "C"-shaped cross-section, the weight should be arranged so that the gap in the cross-section (e.g. the slot of the tube) remains on one side of the optical cable, thereby preventing the grounding device accidentally falling off the cable. In addition, the presence of the weight will improve the electrical contact between the device and the elements (e.g. optical cable, clips or resistive element) lying inside it.

The grounding device is preferably arranged to enable the resistive element to be passed through the interior thereof. For example, the grounding device may be hooked on to the optical cable so that it is supported by the cable and so that there is a small gap between the under surface of the cable and the internal surface of the grounding device, sufficient to allow the resistive element and any clips that attach the resistive element to the optical cable to pass through the grounding device. In one method according to the invention, the internal dimensions of the grounding device are sufficiently small to

ensure that the resistive element touches the internal surface of the grounding device, or alternatively the grounding device includes a resilient contact element that ensures electrical contact with the element. In an alternative method, the clips that are employed to attach the resistive element to the optical cable are electrically conductive so that any induced currents on the resistive element will be passed to earth via the clips and the grounding device. In such a method it is preferred for the grounding device to have a length that exceeds the spacing of the clips so that at least one clip is always in contact with the grounding device. In any case, the grounding device should be sufficiently long to prevent installation personnel standing on the tower from reaching beyond the distal end of the device. Typically the grounding device will have a length in the range of from 1 to 2 metres.

One method in accordance with the present invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is an isometric view of one form of grounding device that may be employed in the method, and

Figure 2 is a schematic side view showing the grounding device of figure 1 during installation of a resistive element.

Referring to the accompanying drawings, an earthing device 1 that may be employed in the method according to the invention comprises a metal tube 2 of approximately 1.2 metres in length which is formed from a metal e.g. stainless steel. the tube has an internal diameter of about 60mm, and has a 20mm wide slot 4 extending from one end thereof to the other. The tube is provided with a pair of lugs 6 and 8, one lug 6 carrying a weight 10 which ensures that the tube 2 is always correctly oriented about the optical cable, and the other lug 8 for connection to an earthing strap.

Figure 2 shows the grounding device 1 during installation of a resistive element 12 as described in international patent application No. PCT/GB94/02675 on an existing all dielectric self-supporting (ADSS) optical cable 14 that extends between one tower 16 and another tower (not shown). At each tower the cable is suspended from a cable clamp 20 which also earths the cable.

The resistive element 12 is sufficiently flexible to enable it to be bent from a vertical orientation to a horizontal orientation in the region where the optical cable is

clamped to the tower, but is sufficiently stiff to enable it to be fed out from the tower in the direction of the arrow a significant length along the optical cable (typically one third of the span length). In order to install the resistive element 12, the grounding device 1 is first earthed by electrically connecting it to the tower 16 via an earth strap 18. The grounding device 1 is then hooked over the optical cable 14 by means of the slot 4 so that it rests on the cable and is separated from the cable clamp 20 by a distance of about 1 metre. The optical cable in the region 22 extending between the earthing clamp 20 and the grounding device is thus maintained at earth potential and may be handled by installation personnel without risk of electrocution.

In the region 22, the end of the resistive element 12 is clipped to the cable 14 by means of electrically conductive clips 24 and is then fed out along the cable so that it passes through the tube 2 of the grounding device. The length of the tube 2 is greater than the separation of the clips 24 so that there is always at least one clip that is located within the tube 2 and which will ensure that any induced currents on the resistive element are passed to ground. When the resistive element has been extended to its full length, the proximal end thereof is permanently earthed to the tower and the grounding device is unhooked from the optical cable.

CLAIMS

1. A method of installing a resistive element along part of an optical cable that extends between, and is supported by, towers of an overhead electrical power transmission system, which comprises attaching one end of the element to the optical cable at a tower, feeding the element out along the cable from the tower, and attaching intermediate parts of the element to the optical cable if necessary, <u>characterised in that</u>:

(i) the optical cable is earthed at a location adjacent to the tower by attaching to the cable a grounding device that is electrically connected to the tower;

(ii) the resistive element is attached to the optical cable at a position on the optical cable between the tower and the location at which the optical cable is earthed by the grounding device, and is fed out along the optical cable from that position, and

(iii) as the resistive element is fed out along the optical cable, it contacts the grounding device which provides a path to earth for induced electrical currents thereon.

2. A method as claimed in claim 1 which includes the steps of:

(a) forming a permanent earth connection between the resistive element and the tower after the resistive element has been fed out to its full extent; and

(b) after the permanent earth connection has been formed, removing the grounding device.

3. A method as claimed in claim 1 or claim 2, wherein the grounding device is substantially "C"-shaped in cross-section so that it can be attached to, and removed from, the optical cable.

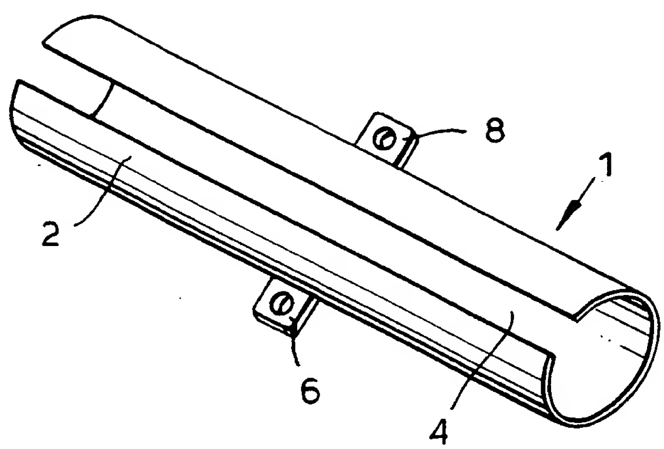
4. A method as claimed in claim 3, wherein the grounding device is in the form of a tube having a longitudinally extending slot to allow attachment and removal thereof.

5. A method as claimed in claim 3 or claim 4, wherein the grounding device includes a weight that ensures correct orientation thereof on the optical cable.

6. A method as claimed in any one of claims 3 to 5, wherein the element is fed out so that it passes through the interior of the grounding device.

7. A method as claimed in any one of claims 3 to 6, wherein the grounding device has a length in the range of from 1 to 2 metres.

Fig.1.



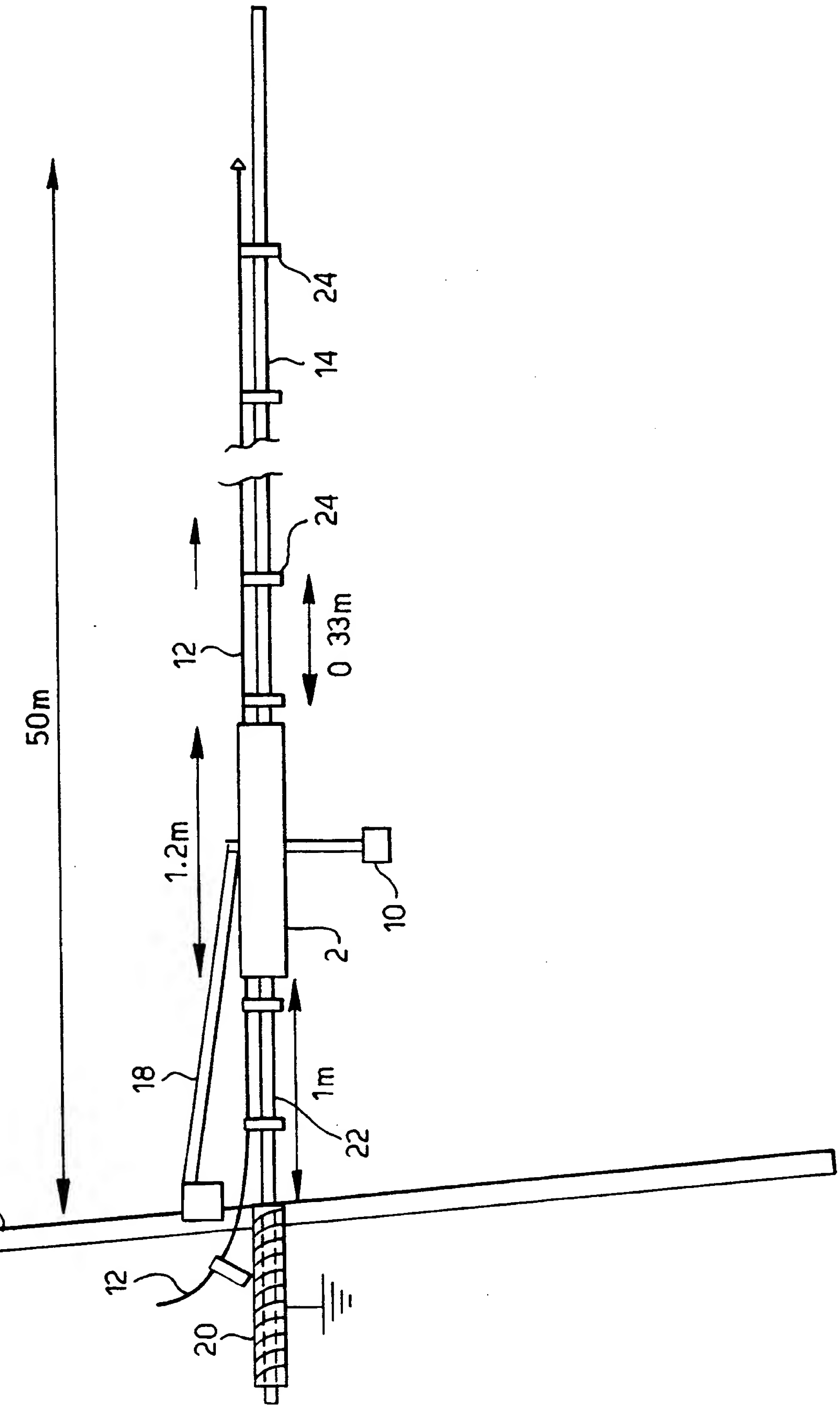


Fig.2.

INTERNATIONAL SEARCH REPORT

Intern. nal Application No
PCT/GB 96/01902

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B6/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 660 149 (BICC PLC) 28 June 1995 see claims; figures ---	1
A	EP,A,0 403 285 (BICC PLC) 19 December 1990 see claims; figures ---	1
A	DE,A,35 06 883 (PHILIPS PATENTVERWALTUNG) 28 August 1986 see claims; figures ---	1
A	WO,A,94 24596 (BICC PLC ;ROWLAND SIMON MARK (GB); PLATT COLIN ANDREW (GB); RICHAR) 27 October 1994 cited in the application see claims; figures ---	1
A	EP,A,0 214 480 (SIEMENS AG) 18 March 1987 see claims; figures --- -/--	1

[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
18 October 1996	25. 10. 96

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A	WO,A,91 16648 (NKF KABEL BV) 31 October 1991 see claims; figures ---	1
A	GB,A,2 264 813 (BICC PLC ;METAL MANUFACTURES LTD (AU)) 8 September 1993 see claims; figures -----	1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 96/01902

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A-0660149	28-06-95	AU-A-	1247695	03-07-95
		AU-A-	7911094	22-06-95
		CA-A-	2138330	18-06-95
		FI-A-	962472	14-06-96
		WO-A-	9516933	22-06-95
		NO-A-	962488	12-06-96
		US-A-	5563976	08-10-96
EP-A-0403285	19-12-90	AU-B-	629353	01-10-92
		AU-A-	5690990	20-12-90
		CA-A-	2018763	14-12-90
		CN-A,B	1048603	16-01-91
		GB-A-	2234830	13-02-91
		JP-A-	3067202	22-03-91
		US-A-	5018825	28-05-91
DE-A-3506883	28-08-86	NONE		
WO-A-9424596	27-10-94	AU-B-	671542	29-08-96
		AU-A-	6573494	08-11-94
		CA-A-	2161007	27-10-94
		EP-A-	0695431	07-02-96
		FI-A-	955013	23-11-95
EP-A-0214480	18-03-87	DE-A-	3684388	23-04-92
		US-A-	4776665	11-10-88
WO-A-9116648	31-10-91	NL-A-	9001007	18-11-91
		AU-A-	7741691	11-11-91
		CA-A-	2081336	27-10-91
		EP-A-	0526518	10-02-93
		US-A-	5317665	31-05-94
GB-A-2264813	08-09-93	AU-B-	670425	18-07-96
		AU-A-	3380693	02-09-93